ASTRO-PHYSICS

1200 GERMAN EQUATORIAL WITH GTO SERVO MOTOR DRIVE

Model GTOCP2

July 27, 2001

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1200 GERMAN EQUATORIAL WITH GTO SERVO MOTOR DRIVE

MODEL 1200GTO PARTS LIST – MODEL GTOCP2

1 Polar axis assembly (right ascension-R.A.) with Servo Box
1 Declination (Dec.) axis assembly
1 Pier top adapter with six (6) 5/16-18 x 5/8" button head screws with washers (these may be attached to your pier post if you ordered one)
1 Stainless counterweight shaft with washer stop and black plastic knob (knob has 5/16 thread)
1 Y cable – R.A. portion is 12.5" long and Dec portion is 37.5" long
1 D.C. power cord (cigarette lighter adapter on one end) - 8' long
1 GTO Keypad controller with 15' coiled cable
1 *DigitalSky Voice*™ Software (CD-ROM)
1 Hex key set
2 8-32 thumbscrews (substitute these for 8-32 set screws that hold GTO Servo Control Box in place, if you wish)

In order to fully assemble your mount, you will need the following items sold separately: mounting plate, 10" O.D. pier, counterweights, and portable rechargeable battery pack (or 110 to 12V DC converter). Several sizes and types are available for your selection. Many of these items will be discussed throughout these instructions.

Several additional options are available:

Longer counterweight shaft – 27" useable length, part # M12661

Santa Barbara Instrument Group CCD Imaging cameras and ST-4 Autoguider - if you plan to pursue CCD imaging or astrophotography

Pier accessory trays for 10" pier and support bars - handy to keep your eyepieces close at hand

Polar axis telescope - threads into the base of the polar axis assembly. We plan to introduce a new polar scope in the near future, please call for details. Many users find a polar axis telescope useful for zeroing in on the pole quickly, particularly with telescopes that are not orthogonal to the mount.

Mounted encoders - you will need these if you plan to use digital setting circles. Keep in mind that these 4000 step encoders which read the position of the shaft are very coarse (324 arc seconds) while the encoder that is built into the servo motor itself is 0.05 arc seconds.

JMI Digital setting circles - The go-to keypad will perform most of the functions of the digital setting circles. One advantage of the JMI unit is the ability to move the telescope by hand while the unit displays your position.

FEATURES AND SPECIFICATIONS

R.A. worm wheel:	10.3", 225-tooth aluminum
Dec worm wheel:	7.2", 225-tooth aluminum
Worm gear:	Brass
R.A. shaft:	3.35" diameter
R.A. thrust bearings:	9.5" diameter
Dec shaft:	2.36" diameter
Dec thrust bearings:	6.5" diameter
Counterweight shaft:	18" useable length, 1.875" diameter stainless steel, removeable
Latitude range:	20 to 68 degrees with or without polar scope or encoders attached (if you are above 65° you will have to remove one pier top knob)
Azimuth adjustment:	Approximately 14 degrees
Setting circles:	Porter Slip Ring design, engraved
Right ascension:	4-minute increments, pointer
Declination:	1-degree increments, pointer
Motors:	Zero-cogging servo motors
Power Consumption:	0.4 amps at the sidereal rate 2 amps both motors slewing
Power requirements:	12 VDC, range 11.5 to 15
Weight of mount:	total -91 lbs. Dec axis -30 lbs. R.A axis - 47 lbs. counterweight shaft -14 lbs.

INTRODUCTION

The 1200 German equatorial was designed to meet the needs of the advanced observer who requires a mount with maximum strength and rigidity and minimum weight. The excess material in both axes has been carved out while retaining a heavily ribbed structure for internal strength and rigidity. A unique dovetail was machined into the mating surfaces of the R.A. and Dec axes. This feature allows quick and easy assembly in the field without any tools.

The DC servo motor drive with GTO computer system, including the keypad controller with its digital display screen and *DigitalSky Voice* software offer extraordinary sophistication for today's observer. Whether you enjoy visual astronomy exclusively or plan an aggressive astrophotography or CCD imaging program, this mount will allow you to maximize your night out under the stars.

The advanced keypad features allow you to slew automatically to objects in a wide range of databases as well as any RA/Dec coordinate. A large selection of common names for stars and other objects makes your selection a snap. The rapid slew rate of 5 degrees per second (1200x) allows you to locate objects very quickly and accurately. You will be very pleased with the intuitive operation of this controller. There are no complicated sequences of keystrokes to remember. It is so easy to use that even it you don't use it for a few months, you will feel at home with the keypad very quickly.

DigitalSky Voice software provides additional capabilities to control the movement of your telescope by using two-way verbal communication with a microphone or by a few clicks of your computer mouse (or touchpad). You can remain at the eyepiece while you direct your telescope with verbal commands. There is no need to put a flashlight in your mouth to see the keyboard. You have total control with your voice and/or mouse. Voice control also allows you to retain your dark adaptation.

The 1200 is equally at home in a permanent observatory or as a portable mounting for remote star parties thanks to the ease with which the two axes come apart. This is the perfect mount for a large refractor, Newtonian, Cassegrain or astrograph.

In order to maximize your pleasure on your first night out, we recommend that you familiarize yourself with the assembly and basic operation of the mount indoors. The temperature will be comfortable, the mosquitoes at bay, and you'll have enough light to see the illustrations and read the manual. Please take particular note of counterbalancing, use of the clutches and operation of the keypad controller.

Why Polar Alignment is Important

Compensation for the Earth's rotation

If you were to take a long exposure photograph with Polaris (often called the north star) in the center of the field, you would discover that all stars seem to revolve around Polaris. This effect is due to the rotation of the earth on its axis. Motor driven equatorial mounts were designed to compensate for the earth's rotation by moving the telescope at the same rate and opposite to the earth's rotation. When the polar axis of the telescope is pointed at the celestial pole (polar aligned) as shown in Diagram 1, the mount will follow (track) the motions of the sun, moon, planets and stars. As a result, the object that you are observing will appear motionless as you observe through the eyepiece or take astrophotos.

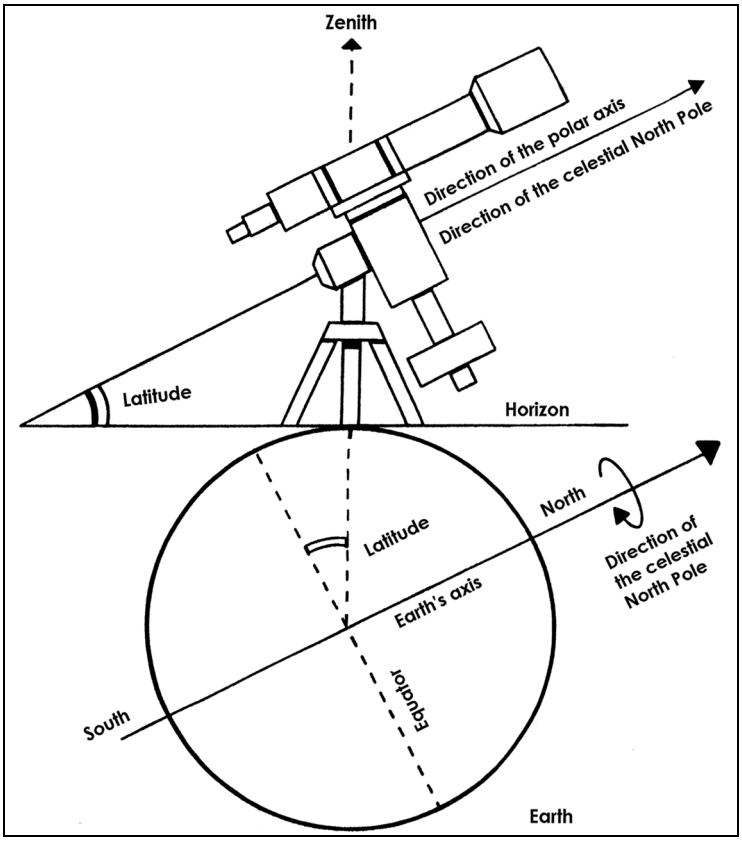


Diagram 1

ASSEMBLY INSTRUCTIONS

Please read all instructions before attempting to set up your 1200 mount. The Model 1200 is very rugged, however like any precision instrument, it can be damaged by improper use and handling. Please refer to Diagram 2 for an illustration of the mount. The parts are labeled so that we can establish common terminology.

The following terms and abbreviations are used interchangeably in these instructions:

polar axis = right ascension axis = R.A. axis = R.A. housing

declination axis = dec. axis = dec. housing

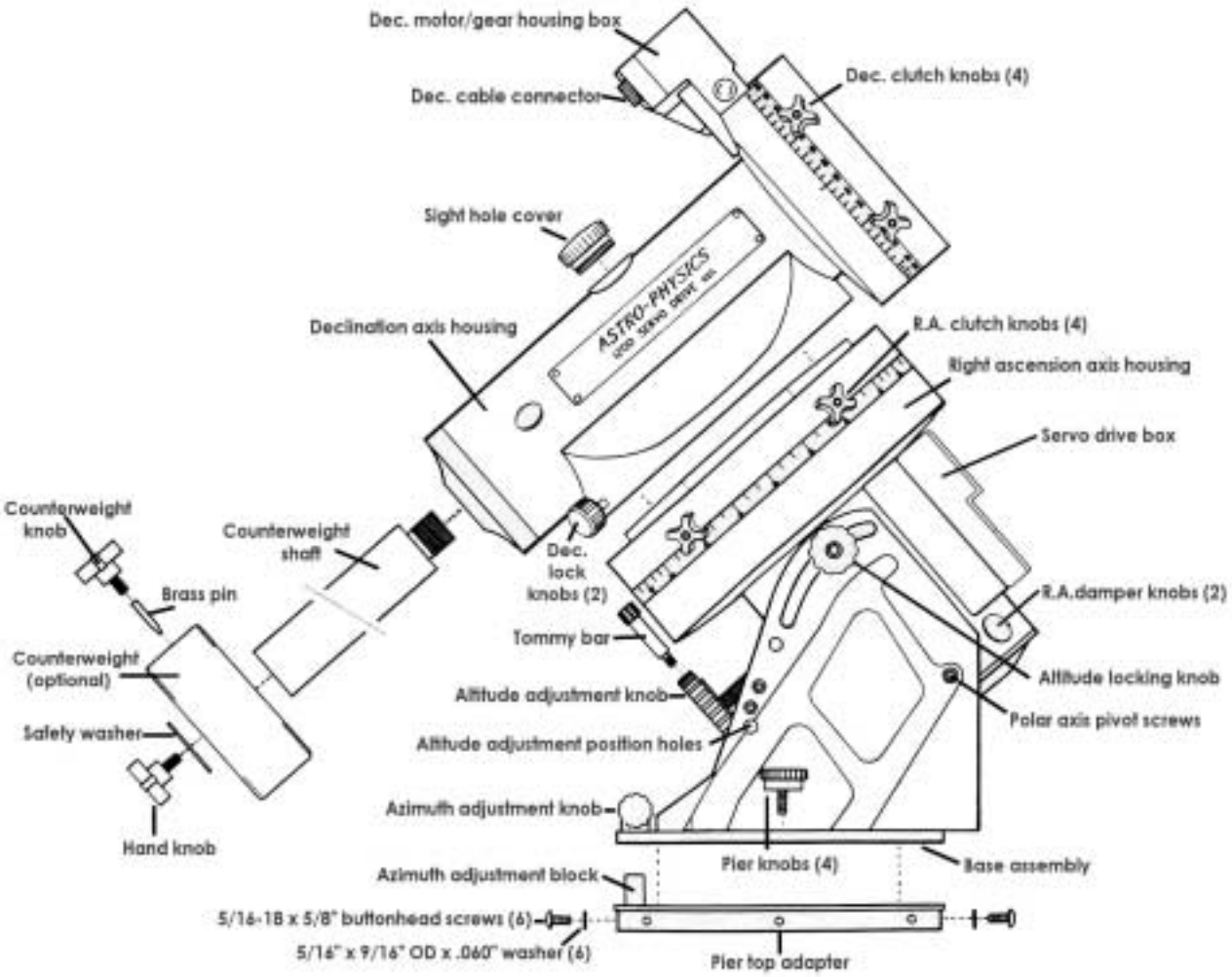


Diagram 2

Before You Leave Home

Since most of us must set up our instruments in the dark, in the cold or while battling mosquitoes, a bit of preplanning and organization is important. There are few simple things that can be accomplished in the comfort of your home before heading outside.

Gross Latitude Adjustment

The total latitude range of the 1200 mount is approximately 20-68 degrees with 4 adjustment positions. Since most astronomers typically observe within one latitude range, this adjustment is made just once, if at all. Prior to shipment, we preset the mount to your latitude range for your convenience. If you travel to another observing location, determine the latitude of your observing site and make the appropriate adjustment.

The four positions for the altitude adjustments have the following approximate ranges:

55 degrees to 68 degrees latitude - top position
37 degrees to 59 degrees latitude - third position
28 degrees to 50 degrees latitude - second position
20 degrees to 37 degrees latitude - bottom position

How to change the position of the altitude adjuster bar

1. Use only the R.A. axis. DO NOT attempt the make these adjustments with the declination axis in place and certainly not with an instrument fully mounted.
2. Loosen both altitude locking knobs about 1 turn.
3. Locate the side of the polar axis that does **not** have the motor/gear housing box. Loosen (about 1 turn) the polar axis pivot screw and altitude adjuster bar fixing screws on this side only. With your hand, push the polar axis upwards so that the altitude locking knobs are positioned at the top of the altitude slot (this is the maximum altitude position). Some resistance will be felt with this operation as you are pushing against the weight of the polar housing and the resistance of the remaining polar axis pivot screw (which has not been loosened).
4. Before attempting to move the altitude adjuster bar, you must tighten the altitude locking knob on the motor/gear housing side. This will prevent any downward movement of the polar axis during positioning of the altitude adjuster bar.
5. While supporting the altitude adjuster bar, remove the two screws that support it on each side (4 screws in all), but keep the two ends of the bar in contact with the side of the mount, don't remove it completely (this tip is for your convenience).

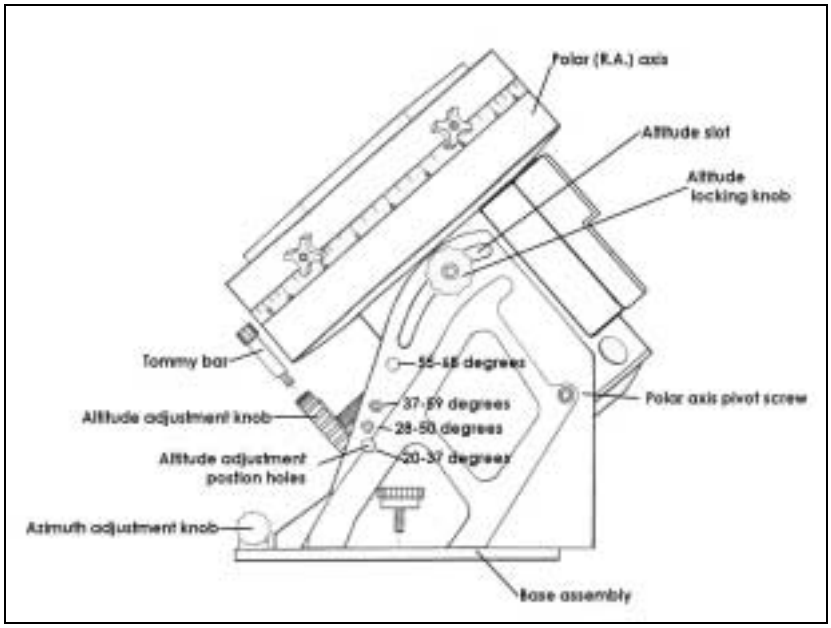


Diagram 3

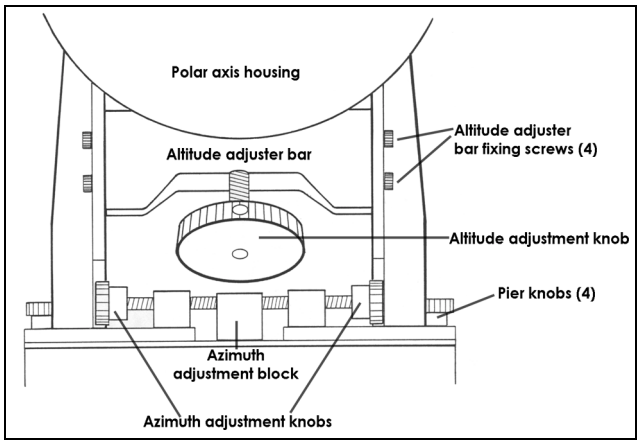


Diagram 4

6. Determine the latitude range that you need (refer to Diagram 3) and position the hole that is marked “A” in Diagram 5 at that location. Note that this hole is located at the rounded part of the altitude bar.

7. Attach two of the screws (one on either side of the adjuster bar), but do not tighten. Rotate the altitude adjuster bar around this pivot point until one of the other holes lines up. Insert the remaining two screws. Lightly tighten so that you still have some ability to move the bar.

8. Note that the altitude adjustment knob is attached to a threaded rod that travels through the altitude adjuster bar. Turn the knob so that the altitude adjuster bar is positioned approximately in the middle of the threaded rod. You should see about half of the threaded rod protruding from both sides of the altitude adjuster bar. This will allow you to move the mount fully within the altitude range.

9. At the end of the threaded rod mentioned in the last step, you will see a small brass altitude adjuster thrust pad. This is the part that will come in contact with the polar axis as you ease it back into position. Loosen the altitude locking knob (motor/gear side) and lower the polar axis so that it rests comfortably on this pad. The threaded rod should be positioned at a right angle to the polar axis housing. Firmly tighten the altitude adjustment screws.

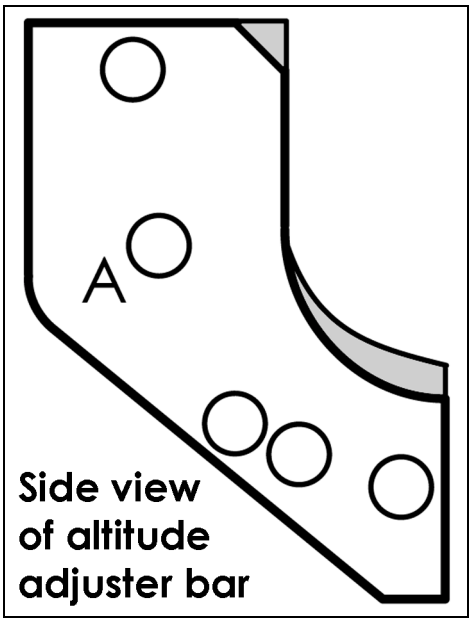


Diagram 5

10. Turn the altitude adjustment knob to raise or lower the polar axis to your approximate observing latitude. Tighten the altitude locking knobs with finger pressure only. You do not need to tighten with the hex key.

11. Firmly tighten <u>both</u> polar axis pivot screws with the hex key.

Attach Pier Adapter to Pier Post

If you purchased the pier from Astro-Physics, the pier top adapter of the 1200 may be already attached to the top of the pier. If you are constructing your own pier or tripod, you will need to incorporate this part. The pier adapter was designed to fit into a 10" x 0.094" wall tube. Use six (6) screws to attach this part. Note that with the Astro-Physics pier, you can orient the pier adapter so that one of the pier legs faces "north" or "south" as you prefer.

Assemble Pier (purchased separately)

Begin by assembling the portable pier at the desired observing location. Note which direction is north.

1. Slide the three legs onto the nubs of the base and rotate the assembly so that one of the legs points toward north (or south, if that is your preference).

2. Place the pier post on the base orienting the center azimuth block directly north. If you choose to have one leg north, then the pier adapter plate will have to be installed with the azimuth block directly over a turnbuckle. If you have one leg south, the pier adapter plate will have to be installed with the azimuth block over and between two of the pier post turnbuckles.

3. Attach the tension rods. The turnbuckles should be drawn tight until the whole assembly is stiff

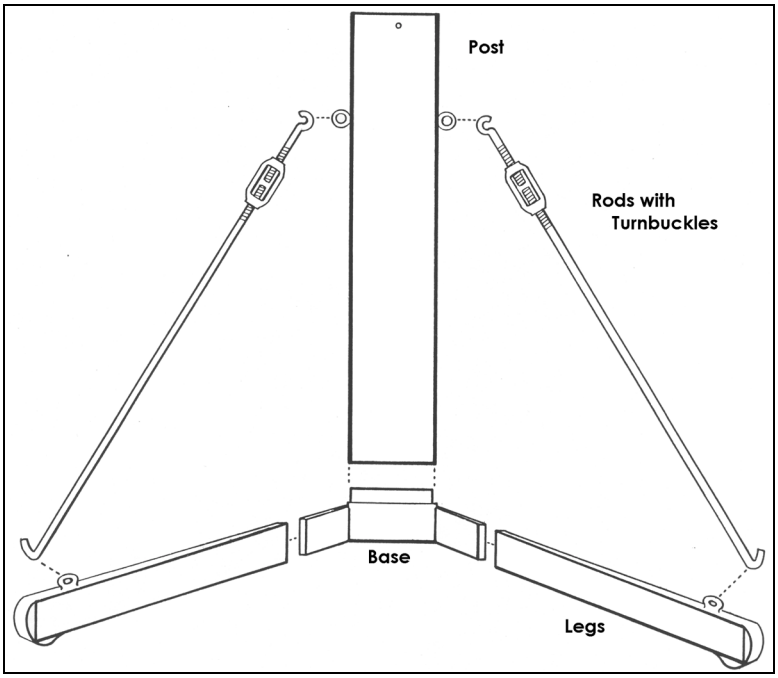


Diagram 6

enough to support your weight without movement.

Assemble Polar Axis Assembly to Pier or Tripod

In order to track the motion of astronomical objects, the polar axis must be positioned so that an imaginary line drawn through the center of the axis points toward the celestial pole. At this stage of the assembly process, you want to position the mount so that it points roughly north.

1. Remove the four (4) hand knobs on the pier top adapter and keep them close at hand.
2. Prior to lifting the polar axis assembly into place, turn the fine azimuth adjustment knobs so that the space between them is wide enough to allow the center azimuth block to fit easily between them. Ensure both pier top and polar axis assembly mating surfaces are clean and free of dirt.
3. Place the polar axis assembly onto the pier top adapter so that the center azimuth block fits between the fine azimuth adjustment knobs.
4. Move the base of the polar axis assembly so that the threaded holes of the pier top can be seen through each of the four slots.
5. Thread the four hand knobs loosely in place (you will tighten these later after polar alignment).

Altitude and Azimuth Adjustments - Rough polar alignment

For rough polar alignment, your goal is to sight the celestial pole when looking through the polar alignment sight hole in the center of the polar axis. You will need to make altitude (up/down) and azimuth (side to side) adjustments to the position of the mount.

We recommend that you do your rough polar alignment with the R.A. axis only since you will be making major adjustments to the position of the mount at this time. The remainder of the mount, telescope and counterweights would add considerable weight and require more hand effort. Later, you will do your final polar alignment with the telescope and counterweights attached, but the adjustments will be small.

1. If the R.A. encoder housing and encoder adapter are installed (part # ENC1200 - Mounted Encoders to use with Digital Setting Circles - are available as an optional purchase), you may remove them to complete these steps. Please refer to the section entitled " Installation of Encoders and Encoder Housings – 1200 Mount". Alternatively, you can simply sight up the side of the polar axis to see Polaris.
2. If you examine the polar axis assembly, you will see that the center of the R.A. shaft is hollow. If you have not done so already, loosen (1/2 turn) the four pier knobs.

   NOTE: If you have already attached the Dec. axis, remove the sight hole cover and rotate the internal Dec. shaft by moving the top of the Dec. axis (or the cradle plate if it is attached) to reveal the sight hole that has been drilled into it. Now, you can look through the shaft to the other side.
3. **Azimuth adjustments**: Move the entire pier or tripod east or west until the mount is oriented approximately towards the pole (an imaginary line drawn through the hollow shaft). Use the two fine azimuth adjustment knobs, one on each side of the mount, to make adjustments. You must back off the opposing azimuth knob in order to move the other knob in that direction. Please refer to Diagram 4.
4. **Altitude (latitude) adjustments**: Loosen the altitude locking knobs. Move the polar axis up or down with the large altitude adjustment knob located in the front of the polar axis assembly. The tommy bar can be positioned in any of the threaded holes located in the altitude adjustment knob. Use this bar to help you turn the knob. Please refer to Diagrams 3 and 4. We have found that fine altitude adjustments also can be made by using the turnbuckle on the north leg of our pier, if used.
5. Continue your azimuth and altitude adjustments until you can sight Polaris in the polar alignment sight hole. At this point, you have achieved rough polar alignment which may be sufficient for casual visual observations if you are not planning to slew to target objects with the keypad. When the R.A. motor is engaged, it will compensate for the rotation of the earth and keep the target object within the eyepiece field of view. Your target object will slowly drift since polar alignment at this stage is only approximate. However, you can make corrections with your hand controller as we will discuss later.
6. Tighten the altitude locking knobs by hand.
7. Tighten the pier knobs firmly by hand.

Assemble Declination Axis

1. Do not have your telescope or counterweights connected to the Dec. axis assembly for either assembly or disassembly of the Dec. and RA axes.

2. Position the R.A. axis as shown in Diagram 7 with the pocket "A" at the top, opposite the altitude adjuster knob. Firmly tighten R.A. clutch knobs.

3. During shipment, the Dec. axis assembly lock knobs will be fully screwed into the Dec. axis. For correct assembly, these lock knobs should be unscrewed at least 7 full turns and no more then 8.5 full turns. This is between 5/16" and 3/8" out from the "shipped" tightened position.
   Note: These lock knobs can be completely removed from the Dec. axis assembly with about 9.5 full turns out.

4. Position the Dec. axis above the R.A. axis as shown in Diagram 8, a light movement (wiggle) in the downward direction (arrow "A") will help to correctly seat the principle dovetail(s) and parallel guides.

5. When both Dec. and R.A. assemblies are fully seated, hand tighten both Dec. lock knobs.

6. Thread the counterweight shaft into the Dec. axis.

7. Remove the hand knob and safety washer from the base of the counterweight shaft. Add sufficient counterweights (10 or 18 lb. counterweights are purchased separately) to the declination shaft to balance the telescope you intend to use. Always use two hands to attach or move them on the shaft.

8. Reattach the hand knob and safety washer to the end of the declination shaft. This will help to prevent injury if someone accidentally loosens the counterweight knob.

   NOTE: Firm tightening of the counterweight knob will not damage the surface of the counterweight shaft. The pin that tightens against the stainless counterweight shaft is constructed of brass. Likewise the bronze sleeve that has been press fit into the center of the counterweight will prevent marring of the shaft as you move the counterweight up and down.

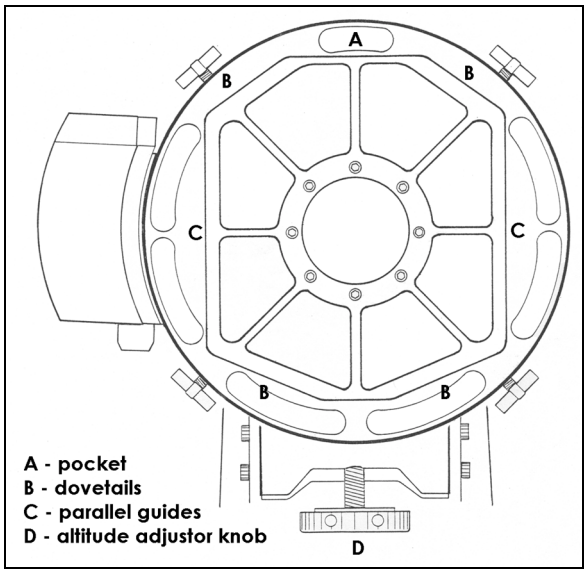


Diagram 7

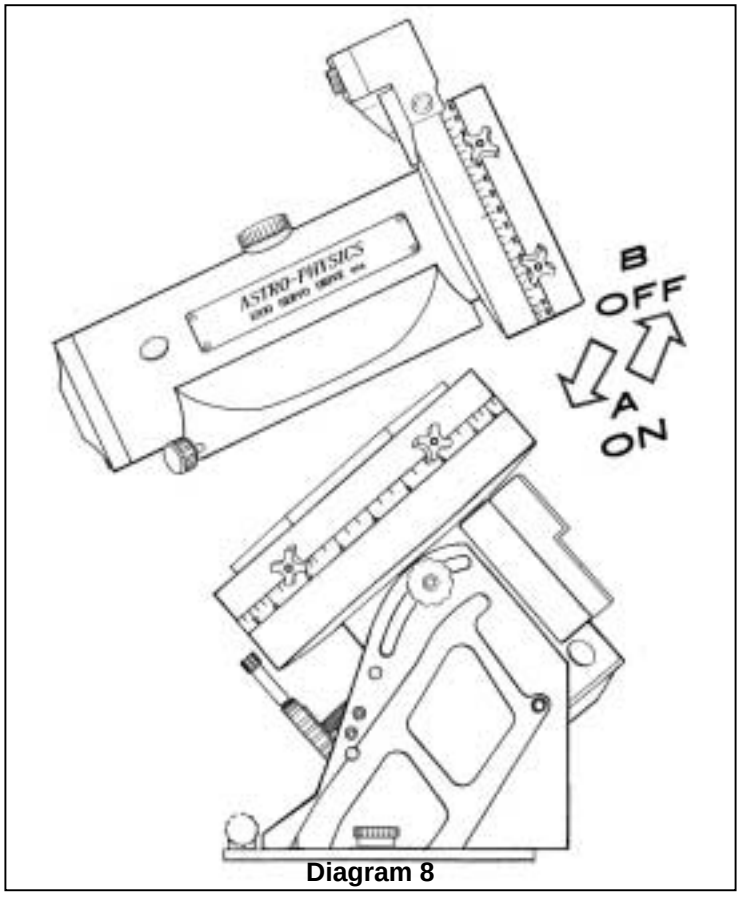


Diagram 8

Removing Declination Axis at the End of your Observing Session

1. Unscrew the lock knobs 5.5 to 7 full turns (this is still 5/16" to 3/8" out from the fully tightened position) and slide/tilt the Dec. axis assembly in an upwards direction (arrow "B").

2. For transport/storage we recommend fully tightening the lock knobs.

Attach Mounting Plate (purchased separately)

Several mounting plates are available for the 1200 mount. If you own more than one instrument, you may need more than one plate. Follow the appropriate directions for the plate(s) that you have.

18" FLAT MOUNTING PLATE (FP1800)

This plate is 18" long and 7.5" at its widest point in the center. The width of the plate tapers to 5.5" at each end. Four pairs of keyhole slots that measure 3.2" between centers are provided. The two inner pairs are 13.75" apart and the outer two pairs are 17" apart. You can drill additional holes to suit your needs. This plate also fits the 900 German Equatorial.

Attach this plate with six 1/4-20 x 1" flat head socket cap screws at the locations indicated by the filled holes on the diagram.

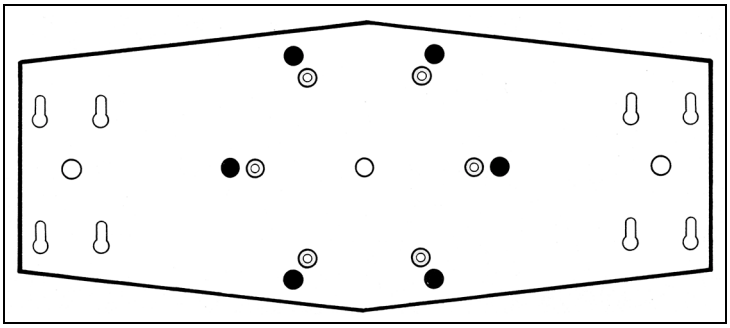


Diagram 9

15" RIBBED MOUNTING PLATE (1200RP15)

This plate is 14.75" long, 7.75" at its widest point 5" at each end and 1" thick. The underside of the plate is carved into a ribbed pattern to maximize the strength and minimize the weight - 3 lbs. A pair of keyhole slots that measure 3.2" between centers are provided at each end. The distance between the pairs is 13.75".

Attach this plate with six 1/4-20 x 3/4" socket head cap screws at the locations indicated by the filled holes on the diagram. Note that the plate is asymmetrical. Attach the plate so that the long end points toward the sky.

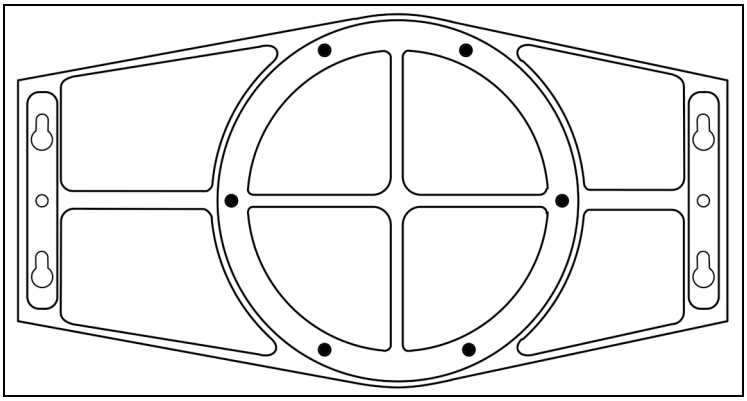


Diagram 10

24" RIBBED MOUNTING PLATE (1200RP)

For larger instruments, the ribbed structure of this plate provides the maximum support. Our machinist begins with thick aluminum plate and carves a strong rib structure. The final result is 1.5" thick, 24" long and 7.6" at its widest point. The width of the plate tapers to 5.5" at each end. A pair of keyhole slots that measure 3.2" between centers are provided at each end. The distance between these pairs of holes is 23". Due to the ribbed structure, you may not be able to drill additional holes for non-Astro-Physics mounting rings. The plate weighs an amazing 9.5 lbs. for its size. This is a view of the rib structure on the underside of the 24" plate.

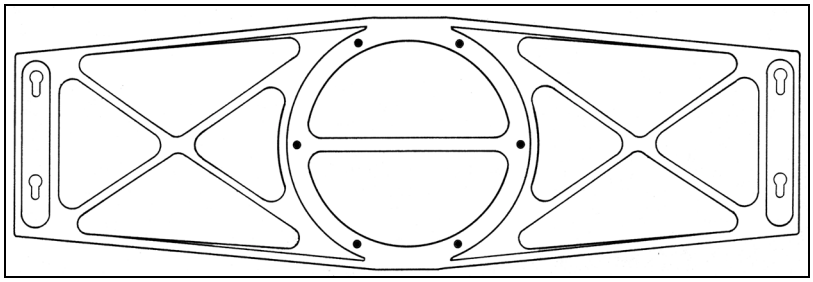


Diagram 11

Attach this plate with six 1/4-20 x1" socket head cap screws at the location indicated by the filled holes on the diagram.

DOVETAIL FOR LOSMANDY D SERIES PLATE (DOVELM)

This Astro-Physics plate attaches to the 400, 600E, 900 and 1200 mounts. If you already own one of the Losmandy DAP series (fits Astro-Physics refractors), DC series (for Celestron 8", 11" or 14" SCTs) or DM series (for Meade 8", 10" and 12" SCTs) plates, this is the mounting plate for you.

Attach this plate with four 1/4-20 x 3/4" socket head cap screws and two 1/4-20x5/8" flat head socket cap screws at the locations indicated by the filled holes on the diagram.

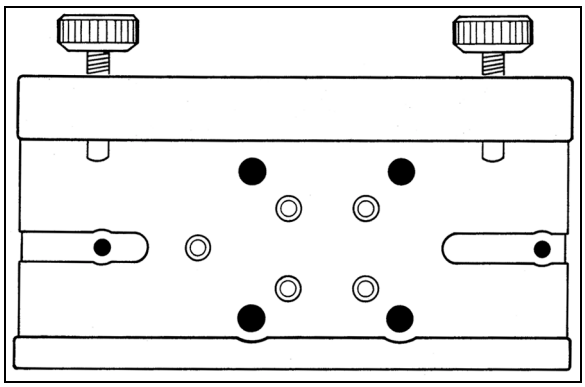


Diagram 12

Attach Mounting Rings (purchased

separately)

Our flat and ribbed plates are constructed with keyhole slots at the location where your mounting rings attach. This feature enables you to partially loosen the screws on your rings just enough to insert them into the larger part of the keyhole, then slide the rings to the narrow part and tighten them with a hex key. You can even accomplish this with the rings on the scope, although this maneuver may be difficult to accomplish with a large, heavy instrument.

We prefer this keyhole method to the standard way of completely removing the screws and dropping them in the grass.

Fine Polar Alignment

For casual observation, you may skip this section and move to “Operation of the Mounting” (tighten your altitude locking knobs (2) and pier knobs first). If you plan to use any of the go-to functions of the 1200GTO or do astrophotography, you must polar align.

Methods for fine polar alignment

- Polar Alignment Scope – Our optional polar scope (PASILL2) will allow you to quickly align your mount on the pole stars. The reticle was designed for use in both the Northern and Southern hemispheres. Even users of the GTO computerized mounts will find these polar scopes useful, particularly if your telescope is not orthogonal to the mount (please refer to the keypad manual for a discussion of orthogonality). If you have a polar alignment scope, please read the instructions sheets that come with it.

- GTO Keypad – Please refer to the instruction manual for the GTO Servo Drive and read the section describing the startup sequence.

- DigitalSky Voice computer program – Please read the corresponding manual.

- JMI Digital Setting Circles – Please read the instructions included with your JMI unit. You must have the encoders installed on your 900 mount (part #1200ENC). Refer to the section of this manual entitled “Installation of Encoders and Encoder Housings –1200 Mount.

- Star Drift method – Traditionally, this has been regarded as the most accurate method of polar alignment, however it is also the most time consuming. If you are planning long exposure astrophotos, we suggest that you use the polar axis telescope, then tweak the final polar alignment by star drifting. Please refer to the recommended reading list at the end of this manual.

Altitude and Azimuth Adjustments

1. Loosen the altitude locking knobs (2) and pier knobs (4) and refer back to the section on “Altitude and Azimuth Adjustments - Rough polar alignment”.
2. Follow one of the methods of polar alignment mentioned above.
3. When polar alignment has been achieved, tighten at these locations (note that the polar axis pivot screws should have been tight throughout the fine polar alignment process):

   Altitude locking knob (2) - hand tighten
   Pier knobs (4) -hand tighten
4. For a permanent installation, all knobs in step 3 above may be firmly tightened with the assistance of a hex wrench.

OPERATION OF THE MOUNTING

R.A. and Dec. Damper Knobs

The R.A. and Dec. damper knobs are <u>not</u> intended as axis locks. They should be tightened with light finger pressure so that a slight resistance can be felt when pushing an unclutched axis by hand. This really adds to the "feel" at the end of the scope with the drives adjusted correctly.

The purpose of the damper knob is to add a bit of friction to the shaft so that gusty winds do not move the axes in their bearings. If there is the slightest amount of backlash between worm and worm wheel, a wind load could theoretically move

the axis back and forth by that backlash amount. Also, in the absence of backlash, there is always a very tiny clearance (.0002") between the shafts and the mating parts. The damper knobs force the shaft to make full contact in 3 places to eliminate the associated play.

R.A. and Dec. Clutch Knobs

1. What do they do?
   The four R.A. and four Dec. clutch knobs depicted in Diagram 2 have the function of connecting the R.A. and Dec. axes to their respective drive worm wheel gears. Their function is progressive, from no tension (axes free to move - as required during correct balancing of the telescope) to a completely "locked up" state.

2. How can you find out what they really do?
   As shipped, all 1200 mounts have all four R.A. and Dec. clutch knobs firmly hand tightened. This will give you a good idea of the maximum tightness (clutch action) that can be achieved by hand effort alone. At this point, you must bear in mind that for optimum performance all four clutch knobs on each axis (R.A. or Dec.) should be tightened evenly with the same tension i.e. all four half tight, all four fully tight, etc.

   In order to feel the effect of the clutch knobs, you may wish to partially assemble your mount. Fit together the R.A. and Dec. assemblies plus mounting plate and counterweight shaft. Do not put scope and counterweights on at this stage. With the above assembly (with the clutch knobs firmly hand tightened - "as shipped"), you can feel the amount of force needed to move each axis by hand. Grab each end of the telescope mounting plate and move it with a backward and forward movement of the Dec. axis. You will feel considerable resistance to this motion. Perform the same operation on the R.A. axis by moving the counterweight shaft backward and forward. With a well balanced telescope, the above tightness of the clutch knobs will be sufficient for all normal conditions of use.

   Now if you proceed to mount up and balance your telescope you can "feel" what this resistance in R.A. and Dec. (movement backwards and forwards) is like when you make these motions from the eyepiece end of your telescope as you would during normal use when slewing (pushing) by hand to acquire an astronomical object within the field of view of your finder or scope.

3. How tight can the clutch be and can you do any damage by pushing against them?
   The maximum tightness of this clutch system is 1/3 turn (with a 5/32 allen key) further in than the tension you can achieve with the knobs by hand. You will see that each clutch knob has a 5/32 hex socket for tightening with an allen key. With this extra 1/3 turn on each clutch knob, the axis (axes) will be considered completely "locked up" and you should not attempt to push your scope by hand against this "locked up" resistance, or undue stress will be placed on the worm wheel/worm and bearings.

   However, if you are undertaking a very long astrophoto exposure, it is advisable to increase the pressure on each clutch knob (with the 5/32 key) by about 1/8 turn on Dec. and 1/8th turn on R.A. You may safely slew the scope by hand with this tension, however you will notice considerably more effort is required to achieve movement. This is the absolute maximum tension that can be used for hand slewing. As a general rule, if you have a big scope (7" or 8" refractor) with all the accessories, you will need more clutch tension than a 5" or 6" scope.

Balancing Your Telescope

For proper operation, the telescope must be adequately counterbalanced. Start by balancing the tube assembly.

1. Tighten the 4 R.A. axis clutch knobs.
2. Loosen the 4 Dec. axis clutch knobs (about 3/4 to 1 turn) so that the telescope moves freely about the declination axis (be careful because if your telescope is significantly out of balance, it may swing rapidly in the out-of-balance direction!)
3. Position the R.A. axis so that the counterweights are in their "lowest" position i.e. the declination axis assembly is in the meridian (this is the usual way that German equatorials are depicted, as shown in diagram 2.)
4. Loosen the tube mounting rings and slide the tube up and down for balancing. This is best done with the tube in the horizontal position.
5. The scope is balanced when it stays put (does not move) with the clutches loose and movement back and forth about the declination axis has the same feel in both directions.
6. Now, tighten the declination axis clutch knobs and position the telescope horizontal and the declination axis horizontal. The center of the counterweights is now the same height as the middle of the tube.
7. Loosen the R.A. clutch knobs (again be careful, because if your scope is significantly out of balance, it may swing rapidly in the out of balance direction).

8. Move the counterweight(s) up or down to achieve the correct balance in R.A. Again, movement back and forth about the R.A. axis should have the same feel in both directions.

9. Try to anticipate any balance problems due to the extra weight of diagonals, heavy eyepieces, finders, solar filters, etc. If the scope moves by itself, when the clutches are loose, then the scope is not counterbalanced adequately. A small amount of imbalance is permissible and indeed desirable.

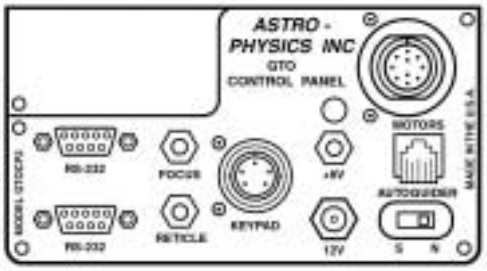
SERVO MOTOR DRIVE

GTO Control Box – Model GTOCP2

The GTO control box contains all of the circuitry to drive the two servo motors and the logic required to navigate the sky. It will be operational and track at the sidereal rate when connected to both motors of the mount and a power source. In order to control the movement of the mount, you will need to connect at least one of these:

- GTO Keypad controller
- Computer with astronomical software such as *DigitalSky Voice* (included) or Software Bisque's*TheSky*™ (purchased separately).

The GTO Servo Control Box is mounted directly onto the polar axes of the 1200 mount. Please remember that this box contains advanced electronics and must be treated with the same care given to other fine equipment. You can see that the unit is built to be rugged, however it is not indestructible.



R.A. and Dec. Cable Connections

A "Y" cable with 10 pin connectors is included with your mount. Attach the connector from which the two cables emerge to the GTO Control Panel. Attach the short part of the "Y" cable to the R.A. motor housing and the long part of the cable to the Dec motor housing. Lock all connectors. Refer to the section below for further information about positioning the cables.

12V Connector

Place the DC power cord (included with your mount) into the phono plug outlet marked 12V on the GTO Control Panel and lock in place. Plug the cigarette lighter plug end of the cord into your power source. The acceptable voltage range is 11.5 to 15. Suggested power sources include: portable rechargeable battery pack, auto or marine battery, or power supply (filtered and regulated) for 110 volts with a minimum output of 5 amps at 12V DC.

There is no on-off switch. We recommend that you plug the power cable into the servo box after the keypad controller. To turn the unit off, simply disconnect the power cable.

Considerations for observatory installations: We suggest that you disconnect your GTO Control Box from 110V when you are not using your mount so that if your observatory experiences a power surge or lightening strike, your mount electronics will not be damaged. If you operate your mount remotely, you will have to leave your power cable connected just as you do for the rest of your electronic equipment. You may want to consider surge protectors or other protective measures to protect from voltage spikes.

POWER Indicator Light

This LED will remain illuminated when your power source has sufficient output to drive the motors. If the voltage falls below 10 volts, the power light will go out and the motors will stop. The keypad controller will not function properly.

For mounts shipped after 02-25-00: If the LED turns yellow, this means that your motors are overloaded, probably due to an unbalanced load on your mount. Refer to the troubleshooting section of the manual for the solution.

KEYPAD Connector

Attach the 5 pin male connector of the keypad controller and lock in place (push in the knurled ring then turn).

RS-232 Connectors

These serial port connections are used to connect your mount to your PC computer. You must provide your own cables with a 9 pin (DB9) male connector to interface with the GTO panel. We have provided the locking posts to secure the cable firmly. If your serial cable does not have a 9-pin connector, you can use a gender changer or adapter to convert it.

When you are controlling the position of the mount with a computer program such as *DigitalSky Voice*™ or *TheSky*™*,* the microprocessor chip located in the servo drive box will send continual RA and Dec coordinate data via the cable connections to your computer. When you use the software to give instruction to slew to a new object, the commands (RA and Dec coordinates) are sent to the mount.

We provide two serial port connections on the mount so that you can use two software programs simultaneously. For instance, you can give verbal commands in *DigitalSky Voice* while using *TheSky* as a planetarium program. Since the mount will update the RA and Dec coordinates simultaneously, both programs are continually updated with the data from the mount. You can watch the screen display of *TheSky t*o see where your telescope is pointing as it slews. This is most effective if you have a reasonably fast computer with plenty of RAM. If you try this with a 100MHz processor and only 32 MB of RAM, the response time will be slow since both programs must be continuously updated with position data.

You must have two serial ports available on your computer to take advantage of this feature. If you use a laptop, you may need to purchase a PCMCIA adapter to gain an additional serial port. Socket Communications offers adapters for many computers. Check out their web site at www.socketcom.com.

FOCUS Connector

Attach the 2.5mm phono plug connector of your JMI Motofocus or Meade electric focuser (optional accessories) here. Refer to the section regarding focus adjustment in the GTO Keypad Manual for instructions on using the keypad controller to adjust focus. Alternatively, you can verbally control the focus using the Focus Mode of DigitalSky Voice software.

RETICLE Connector

If you wish to use a plug-in type guiding eyepiece with an illuminated reticle (available from several manufacturers), insert the 2.5mm phono plug into this connector for power. Reticle brightness can be adjusted with the hand control. Refer to the section pertaining to reticle illuminator adjustment in the GTO Keypad Manual for further information.

AUTOGUIDER Connector

This connector interfaces with the RJ-11-4 modular jack of an autoguider cable, purchased separately or as part of a CCD Imaging Camera or Autoguider. The autoguider will be functional and ready to go as soon as you plug it in. Please refer to the appropriate manual from the manufacturer for operation of the autoguider.

We offer CABTIC (Tracking Interface Cable for SBIG ST-4 and ST-6 camera) and CAB7/8RC (Relay cable for SBIG ST-7, 8,9 and 10 cameras). Please refer to our price list or call for further information.

+6V Connector

This 6 volt output accepts 2.5mm phono plugs. It is used primarily to power the Pentax 6x7 camera directly from the mount with a cord sold for that purpose (our part # CORD01).

N and S Switch

Select northern (N) or southern (S) hemisphere as needed. When you slide the switch to the opposite position, the tracking direction of the drive will reverse. The power cord must be removed and re-attached to make this work.

Prevent the Cables from Tangling

The movement of the mount across the meridian during slewing functions is calculated so that the cables will not tangle if they are set up properly. In addition to the motor and power cables that are provided with the mount, you may have additional cables for other accessories. These may be powered from the GTO Control Panel or from another power source. We suggest that you position your cabling carefully to avoid a tangled mess. When your cables are set up, move the telescope manually throughout the normal range of movement to be sure that the cables do not catch on anything and that you have enough length. Here are a few pointers:

1200 Motor Cables

Note that the "Y" cable for the 1200 mount originates at the GTO Control Panel connector, then splits into two. The short portion connects to the RA motor box and is not likely to be in the way because this axis remains in the same position. The longer Dec portion of the cable must be set up properly to ensure that as the Dec axis moves, the cable follows smoothly. Please insert this cable into the cable mount in the upper left corner of the GTO Servo Control Box as shown above. When the connector is attached to the Dec motor box, the cable should be positioned as shown in the photograph.

Accessory Cables

Accessories may include Kendrick Dew Removers, CCD cameras and autoguiders, focus motors, illuminated guiding eyepiece reticles, power cords for the Pentax 6x7 camera, etc. As you attach each accessory, carefully assess the best position to assure complete movement as your telescope slews from one side of the mount to the other. If an external power source is used, determine the optimum location for the battery. We prefer to use tie wraps (not glamorous, but effective) or cable ties (from electronic supply store or catalog) to secure our cables to the mount, telescope, rings or bind them together. Plastic adhesive cable mounts, available from electronic supply stores, are an alternative choice. We prefer to use ties since we cannot bear to attach adhesive cable mounts to our telescopes or mounts.

If we use tie wraps to secure several cables together and plan to use that same setup in our next observing session, we keep the ties in place when we disassemble our equipment. The setup for the next session is much quicker.

Removing the GTO Control Box From 1200 Mount

The GTO control box can be removed easily from the RA axis. It is secured by two 8-32 set screws located at the base of the GTO Servo Control Box. Loosen the screws with one of the hex keys from the set included with the mount. Lift the box up from the bottom and tilt so that it frees from the dovetail connection.

Some people have a permanent observatory, yet prefer to store their electronics in their home to keep them clean and free of cobwebs. If you do, you may wish to substitute the 8-32 thumbscrews (included with your mount) for the set screws. This will allow you to remove and install your GTO control box without tools.

GTO Keypad Controller Operation

Please refer to the manual for the GTO Keypad Controller for complete instructions.

MOUNT MAINTENANCE AND ALIGNMENT

Under normal operating conditions, minimal maintenance is required. Every 12 months the clutch knobs (4 for Dec. and 4 for R.A.) should be removed and 1 or 2 drops of light oil (3 in 1 household oil) should be put in the exposed hole. If the R.A. and Dec. axes are attached together for a long time in outside conditions (i.e. in a permanent observatory) then the mating surfaces should be lightly oiled or greased - if you expect to get them apart again after 10 years.

Your 1200 is a precision instrument with very accurate worm and wheel adjustments. Please be careful if you place the mount on a flat surface, i.e. the ground or trunk of your car. The gear alignment may be affected if the R.A. and Dec. motor/gear box assemblies sustain undue lateral force. This is true of any fine instrument. We suggest that you transport and store the mount in a case or in a well padded box.

TROUBLESHOOTING

Additional troubleshooting questions are in the GTO Keypad Controller manual. Please refer to them.

The LED on the GTO Control Box changes from red to yellow and the motors stop or goes out completely (for mounts shipped after 02-25-00).

1. The motors are overloaded, probably due to an unbalanced load on your mount.

   Rebalance your telescope, and then press one of the N-S-E-W buttons to reset the keypad. Re-enter the last object on your keypad and the scope will slew to the correct position. Even though your motors had stopped, the logic in the control box retained the scope position in memory. As long as you didn't change the pointing position of the scope, you are still calibrated.

   If the scope was moved during re-balancing, simply enter a nearby bright star on the hand controller, press GOTO and allow the mount to finish slewing. You can then move the scope manually or with the N-S-E-W buttons to center the star in the eyepiece, and press the #9 RECAL button. This will recalibrate the mount.

   Additional explanation: The GTO drive circuit includes logic for overload protection to prevent burning out the expensive servomotors in case of severe overload on the two axes. The primary cause is an unbalanced load in R.A. If the extra load opposes the motor rotation, the motor must work harder to track at the sidereal rate and the current will rise to high levels. If the current exceeds the trip point for more than a minute, the logic will shut the motor off and tracking stops. It typically takes about 4 lb. of unbalance to trip the overload, but a very heavy load of scopes, accessories and counterweights on the mount can decrease this unbalance threshold.

2. The voltage of your battery has probably gone below 10.5 volts.

3. The current rating of your AC-DC power supply is too low.

   Additional explanation: During slewing, the two motors draw up to 3 amps from a 12 volt source. This may increase when the temperature approaches freezing or below. It is recommended that your supply be rated at 5 amps, 12 volts DC minimum (18 volts max.). If you also power other equipment (CCD cameras, dew heaters, etc.) from the same source, you will need a supply capable of up to 10 amps. The more equipment you have, the more current capability you will need. For portable applications, we recommend a heavy-duty marine battery designed for deep discharge applications. The most common problems are due to inadequate power supply.

The keypad reset (or locked up) when I plugged my CCD camera, PC (or other equipment) into the same battery as the GTO mount was using. The battery has a meter which shows 12V.

The meter is reading an average and will not show dips. Gel cells have internal resistance, which will cause voltage drop when the load changes. When you connect an additional CCD camera and PC the load will drop below 9 volts and the keypad will reset or it may affect the GTO circuit itself and cause the keypad to lock up.

We recommend that you use a large marine battery that is not a gel cell and hook everything up to it before calibrating the GTO.

If any problems occur, please don't hesitate to contact Astro-Physics for assistance.

ASTRO-PHYSICS INC
11250 Forest Hills Road
Rockford, IL 61115
Telephone: (815)-282-1513
Fax: (815)-282-9847

Recommended Reading from our Staff:

The Backyard Astronomer's Guide, Terence Dickinson and Alan Dyer, Camden House Publishing, 1991
The authors, both former editors of *Astronomy* magazine, offer practical insight into astronomical equipment, finding your way around the sky, polar alignment, using setting circles, and astrophotography. This book provides excellent explanations and is well organized and illustrated.

All About Telescopes, Sam Brown, Edmund Scientific Company, 1975. Excellent information regarding the principles of mount construction and operation, using setting circles, eyepiece projection, etc. Illustrations and formulas galore. Many of the instruments pictured are outdated, however the underlying principles are timeless.

Norton's 2000.0 Star Atlas and Reference Handbook, edited by Ian Ridpath, J. Wiley Publishers, 1989.
Star maps, information regarding polar alignment of German equatorials and observing techniques.

INSTALLATION OF ENCODERS AND ENCODER HOUSINGS -1200 MOUNT

1200ENC (purchased separately)

Parts List:

1 Right Ascension (R.A.) Encoder housing (black anodized)
1 Declination (Dec.) Encoder housing (black anodized)
1 R.A. Axis Adapter (clear anodized - silver colored), labeled R.A.
1 Dec. Axis Adapter (clear anodized - silver colored), labeled Dec.

To install your encoders, first remove the telescope from your mount. Remove your declination counter weight(s) and declination counterweight shaft.

Fitting Declination Encoder Housing

If the encoders were purchased with the 1200 mount, it is likely that the declination axis adapter and encoder housing have already been installed. No further action will be required as this encoder will remain in place.

1. If the encoders were purchased separately, the silver-colored Dec. axis adapter may be inside the black Dec. axis encoder housing. If it is, remove it now.

2. Locate the counterweight shaft adapter (the black anodized part that the counterweight threads into) on the Dec. axis. When we assembled the mounts, we threaded this on rather tightly, so you will need some extra leverage to remove it. Locate the hole that was drilled into the part and find some object that you can insert. We suggest that you use one of your allen head wrenches that is wrapped in masking tape so that you do not mar the finish of the part. You may need to apply a good deal of force so it may be easiest to do if the mount is on the pier so that it won't move.

3. Thread the Dec. axis adapter into the end of your Dec. axis Final tightening should be done with firm hand pressure. Normally the Dec. axis adapter will not be removed.

4. If you look into the black encoder housing, you will see the encoder itself mounted at the rear of the housing. When this installation procedure is complete, the encoder shaft will insert into the center hole of the Dec. axis adapter. This allows the encoder to read the motion of the declination shaft as the declination axis moves.

5. Thread the Dec. encoder housing onto the Dec. axis housing of the 1200 mount. You may need to wiggle the encoder housing gently to engage the shaft of the encoder with the hole in the center of the Dec. axis adapter. When the threading is complete, tighten up with firm hand pressure (or insert your special "tool" from above and tighten firmly) since normally this encoder housing will not be removed.

6. The counterweight shaft may now be rethreaded into the rear of the Dec. encoder housing.

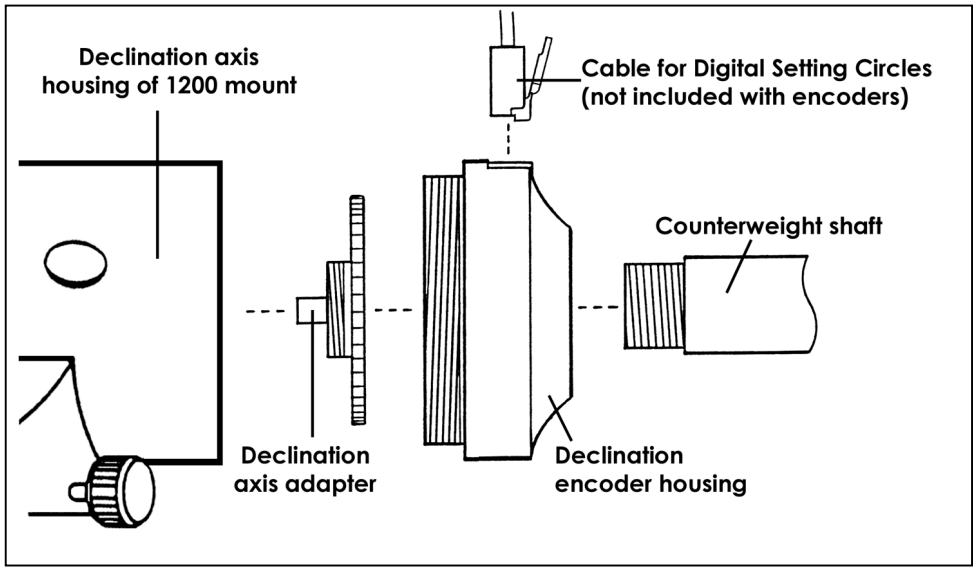

Declination axis housing of 1200 mount
Cable for Digital Setting Circles (not included with encoders)
Counterweight shaft
Declination axis adapter
Declination encoder housing

Diagram 13

Fitting Right Ascension Encoder Housing

If the encoders were purchased with the 1200 mount, it is likely that the right ascension axis adapter and encoder housing have already been installed. Please continue to read these directions since you may need to remove and reinstall the encoders if you use a polar alignment scope. Since the polar axis telescope and R.A. axis adapter thread into the same location, you will need to switch back and forth between them as needed. If you use the JMI NGC MAX or Mini MAX Digital Setting Circles, you can use the "polar align" mode in these units instead of a polar alignment scope!.

1. If the encoders were purchased separately, the silver-colored R.A. axis adapter may be inside the R.A. axis encoder housing. If it is, remove it now.
2. Thread the R.A. axis adapter into the end of your R.A. axis (if your polar alignment scope is fitted you must remove this first along with the polar alignment scope adapter). Use moderate hand pressure to tighten the R.A. adapter since you may need to remove it to install the polar axis telescope at a later time.
3. If you look into the black encoder housing, you will see the encoder itself mounted at the rear of the housing. When this installation procedure is complete, the encoder shaft will insert into the center hole of the R.A. axis adapter. This allows the encoder to read the motion of the R.A. shaft as the right ascension axis moves.
4. Now thread the R.A. encoder housing onto the R.A. axis housing. You may need to wiggle the encoder housing gently to engage the shaft of the encoder (located within the R.A. axis housing) with the hole in the center of the R.A. axis adapter. Again, use moderate hand pressure as you may wish to remove this at some time.
5. The hardware for your encoders is now installed. For actual set-up procedures for Micro MAX, Mini MAX or NGC MAX, digital readouts refer to the relevant operating manual from the manufacturer. We provide some startup tips in our instruction sheet entitled “Using JMI Setting Circles”.

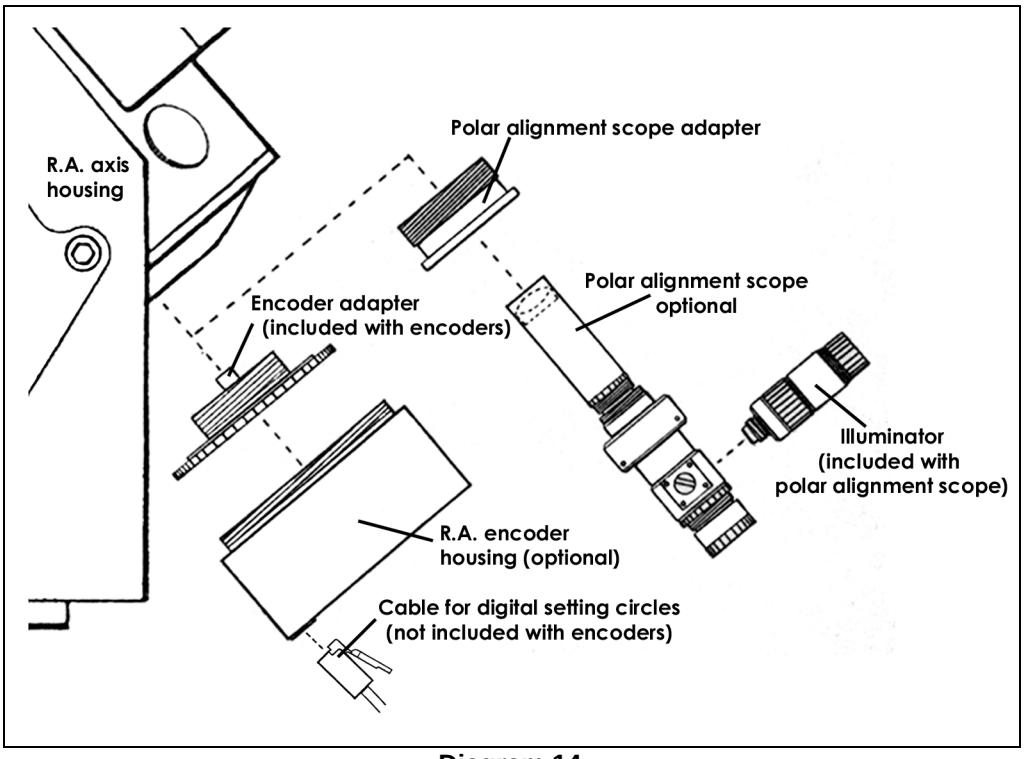

Polar alignment scope adapter
R.A. axis housing
Polar alignment scope optional
Encoder adapter (included with encoders)
Illuminator (included with polar alignment scope)
R.A. encoder housing (optional)
Cable for digital setting circles (not included with encoders)

Diagram 14

Periodic Maintenance

If you remove the R.A. encoder frequently, you may wish to use a very tiny amount of auto grease on the mating threads.